CREDA

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Solar Swimming Pool

CREDA is a program which has been jointly funded by Energy, Mines and Resources, Canada and the Yukon Government, Department of Economic Development and Tourism. For more information or copies of reports contact the Energy and Mines Branch, Yukon Government, Box 2703, Whitehorse, Y1A 2C6.

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FOREWORD

The availability of secure and affordable energy supplies is a subject of national concern. Our primary energy sources are becoming more costly and less accessible. However, Canada has both the resources and technical expertise needed to develop renewable and alternative sources of energy.

The Government of Yukon and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement as one means of pursuing this end. Cost shared by the territorial and federal governments, CREDA has a budget of $3.5 million and is dedicated to the development and demonstration of conservation and renewable energy technologies.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.

- To develop broad public awareness of the potential of renewable energy and conservation technology.

- To provide opportunities for the commercial application of the technologies.

- To create economic spin-off benefits for manufacturing, industry and commerce.

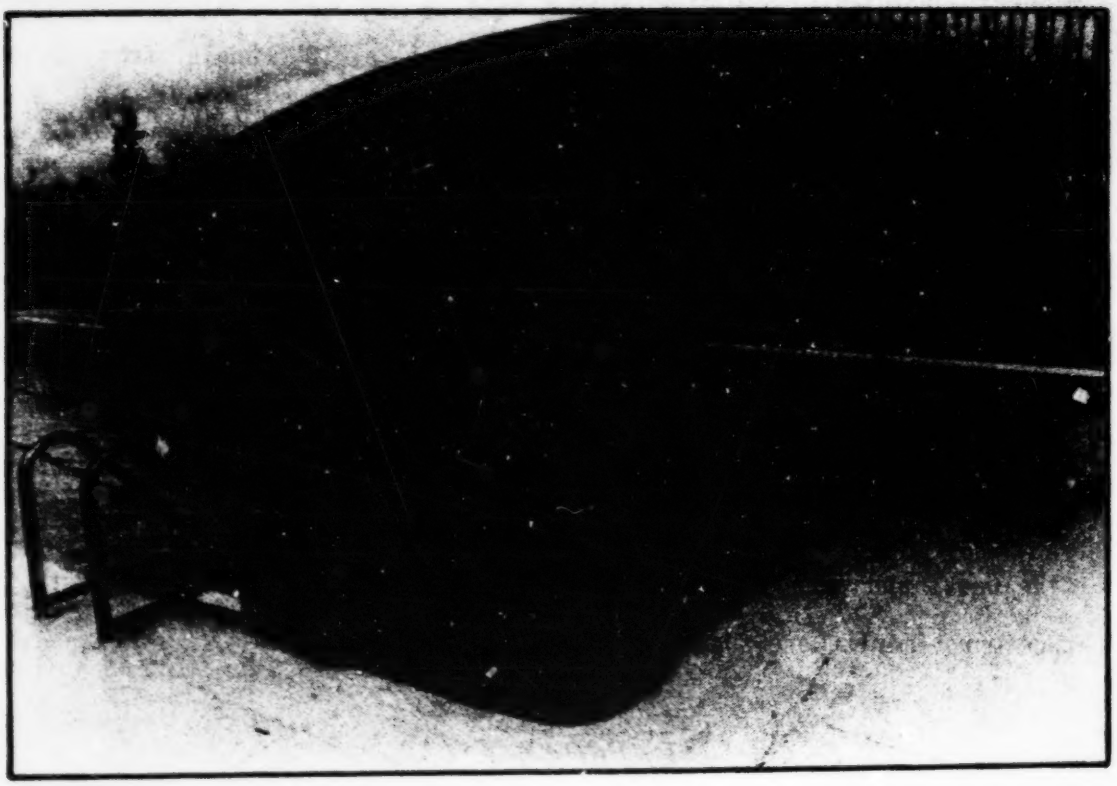
- To create employment in new or existing energy-related industries.

The solar heated swimming pool project described in this report is an important attempt to illustrate the feasibility of using readily available solar energy to heat seasonal swimming pools in a northern climate.

EXECUTIVE SUMMARY

The following report examines the feasibility of using solar collectors to heat the water in a previously unheated outdoor swimming pool. The solar system is used in conjunction with a pool blanket, purchased at the same time, to conserve heat when the pool is not in use. Energy losses through evaporation can be reduced by as much as 70% by a pool blanket. A total of 130 m^2 of highly durable black synthetic collectors were installed on a support structure at a 30^o angle from the horizontal, oriented to the south. Circulation of pool water through the collectors, which is controlled by a differential thermostat, was done with the existing pool pump.

Before installation the pool temperature averaged 16^oC; after installation it ranged from 20^o to 26^oC. It was hard to distinguish how much pool heating was due to the solar system and how much heat was retained by the pool blanket. However the pool season was extended by five weeks and attendance tripled, which is a good indication that the two improvements were successful.

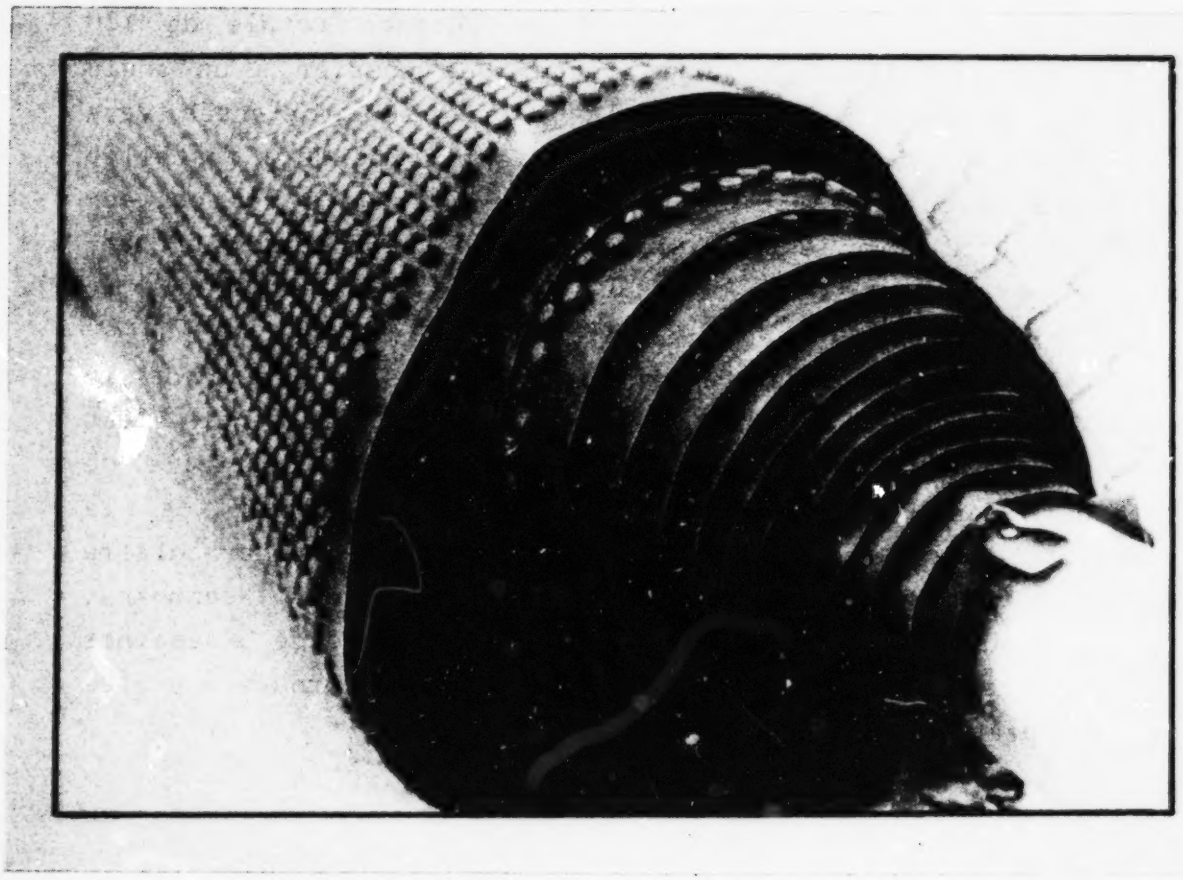


The Mayo Pool. Solar Collectors are positioned on the sloped roof.

Résumé pour l'exécutif

Le rapport suivant examine la possibilité d'utiliser des collecteurs d'énergie solaire pour chauffer l'eau d'une piscine extérieure qui n'était pas chauffée auparavant. Le système de chauffage à l'énergie solaire est utilisé conjointement avec une couverture de piscine, achetée en même temps, qui sert à conserver la chaleur lorsque la piscine n'est pas utilisée. Une couverture de piscine peut réduire de 70% les pertes énergétiques engendrées par l'évaporation. Des collecteurs synthétique noirs très durables, d'une surface totale de 130 m^2, ont été installées sur une armature de soutien à un angle de 30° par rapport à l'horizontale et ils sont orientés vers le sud. On s'est servi de la pompe de la piscine déjà installée pour faire circuler l'eau de la piscine à travers les collecteurs; la circulation est contrôlée par un thermostat différentiel.

Avant l'installation, la température moyenne de l'eau de la piscine était de 16° C; après l'installation, celle-ci s'est maintenue entre 20° et 26° C. Il a cependant été difficile de déterminer dans quelles proportions l'accroissement de la température de l'eau est due au système d'énergie solaire ou à la couverture de piscine qui retient la chaleur. Néanmoins, la durée d'ouverture de la piscine a été prolongée de 5 semaines et le nombre des baigneurs a triplé, ce qui prouve que les deux améliorations apportées ont porté fruits.



Insulating Blanket covers pool at night

INTRODUCTION

The Mayo Local Improvement District in conjunction with the Canada/Yukon Conservation and Renewable Energy Demonstration Program tested the use of solar collectors in heating a previously unheated outdoor swimming pool. The pool is filled with naturally heated ground water at 11^{o} - 13^{o} C. Mayo is a small community of 460, located 400 km north of Whitehorse, Yukon.

The community's swimming pool is 25 m x 8.7 m and is heated with 130 square metres (m^2) of black plastic solar collectors. A floating pool blanket with rollers for easy handling was installed to prevent heat loss when the pool was not in use. The solar system was mounted on a specially built roof structure at a 30^{o} angle from the horizontal, facing south.

The purpose of the project is to demonstrate the feasibility of solar heating of pools in far northern climates. Energy conservation techniques are playing an increasingly significant role in swimming pool heating in Canada. Solar pool heating systems are the simplest types of solar applications. It requires that a large volume of water be heated a few degrees above the ambient during the portion of the year when the greatest amount of sunlight is available and air temperatures are the warmest. The sun is a very diffuse source of energy and, even though the temperature increase required is small, the large volume of water requires a substantial amount of energy to heat it adequately.

Substantial area of solar panels is necessary to obtain noticeable effects from the system; usually collector area is half the pool surface area.

PROJECT DESCRIPTION

A total of 130 m^2 of SolaRoll collectors were installed on a roof structure to heat the water in the Mayo Swimming Pool. SolaRoll collectors are made from a highly durable black synthetic substance that is resistant to severe weather conditions. Each four foot high collector has sixty circulation tubes running its full length to maximize absorption. Water is circulated in a highly efficient counterflow pattern which also helps eliminate hot spots.

A special roof structure was built to support the collectors as the existing roof was a flat trailer top. It was oriented to the south and sloped at an angle of 30^{o} from the horizontal as it was for summer use only. The angle is not as critical as it is with domestic hot water systems.

The system is tied into the water circulation system for the pool filters and circulation through the collectors is accomplished by the 5 horse power motor. As this pump runs 24 hours per day, a motorized three-way valve controls whether water goes up through the collectors or simply back to the pool. This valve is connected to sensors in the collectors and the pool water. Water automatically by-passes the collectors on cool days and nights and when pool temperature reaches 29^{o} C.

It is physically impossible to route all the output from the main pool pump through the collectors. The valves are set so that when the collectors call for water approximately 200 litres per minute are sent up. At this rate half or more of the pool's water would go through on a sunny day.

While the solar collectors were used for gaining heat, a pool blanket was used as a measure of conserving heat. Energy loss from a pool occurs primarily through evaporation losses from the surface which can be reduced by as much as 70% by a pool blanket.* While they are a recent innovation, enough is known about their performance to state that, when properly used, they can have a significant impact on supplementing heating requirements.

* Department of Energy, Mines and Resource, Ottawa, The Potential of Solar Energy in Pool Heating in Canada 1980 - 2000, 1980.

MONITORING

Records were kept of the pool temperature and of attendance in the latter part of the 1983 season and early part of the 1984 season, but they were done in such a way as to be almost totally meaningless. There is no indication of the time of day at which the pool temperatures were taken or even if the temperatures were taken on a daily basis.

Attendance records were also taken without any indication as to the days on which they were taken or if such factors as school lessons or public events influenced them.

PERFORMANCE

No records were kept of pool temperatures before the solar project was installed but, according to the Mayo L.I.D. officials, it averaged 16°C. Ideal pool temperature is 27°C.

Due to the erratic nature of the data collected, only very generalized statements can be made on how the system worked.

When the system began operating in the summer of 1982, pool temperatures from mid-June to the first week in August varied from 20°C to 26°C with an average temperature of 23°C. In the 1983 season from the last week in May to the end of June, pool temperatures ranged from 10°C to 24°C, with an average of 19°C. It is hard to differentiate how much heat was conserved by the blanket and how effective the solar heating would have been without it.

On the hot day of 28° C with no wind, the water going through the collectors gained between 8° C and 10° C on a single pass. On an average summer day in the low 20's °C with scattered clouds and a slight breeze, the water gained 6° to 7° C on a single pass. In the early evening it could gain 2° C. Daily gains in pool temperature varied from 2° to 10° C over the season. The collectors were operating 10 to 12 hours in June and six to seven hours in August.

However, both improvements were regarded as being very successful by the pool manager. The pool season was extended by about five weeks and attendance tripled. If these are an indication of the success of the project, then the use of the solar collectors and blanket has done much to improve the value of the pool.

BUDGET REVIEW

The cost of materials and installation of the solar system was estimated to be $20,000. The actual cost was $22,186. Both figures include $4,000 for building a support structure for the collectors as the existing roof is a flat trailer top. The Mayo L.I.D. contributed a substantial amount, nearly one-third the total.

Budget to Actual	Budget	Actual
Collectors	$10,080.00	$10,368.00
Other Hardware	6,890.00	5,736.70
Labour	3,560.00	5,343.50
Freight	270.00	452.03
Other Costs: Lodgings		185.00
Tool Rental		101.00
Total	$20,800.00	$22,186.23

ECONOMIC BENEFITS

As the pool was previously unheated and therefore there were no energy costs, the economic benefits are nil in terms of reduced fuel consumption and operating costs. It is impossible to calculate how much money was saved over a season or the rate of return on the investment.

The fact that the pool water was heated to a certain extent by the solar system means there is potential savings in fuel consumption by using solar energy. However, detailed records of operating costs and weather conditions would have to be available on a site specific basis to carry out a more accurate economic analysis.

Other benefits that resulted from the solar system were more pleasant water temperatures and a five week longer season. Attendance tripled without any significant population increase. Income from admission fees would also have increased.

ENERGY IMPACTS

There is no doubt that solar systems installed on swimming pools do result in a saving on fuel consumption, but just how much is a function of many factors, such as hours of sunshine, desired pool temperature, and collector efficiency.

The use of pool blankets is one of the most effective ways of reducing heat loss and thereby reducing fuel consumption for heated outdoor pools. Analysis of natural pool temperatures for a variety of pools across Canada indicates that uncovered pools require a seasonal input of 100 kJ to 1,500 kJ per litre of pool water to maintain a 27^{o} C noon-time pool temperature between May 15 and September 15 compared with between 0 and 200 kJ for a covered pool.* Pool blankets have less impact on heating requirements for indoor pools as both the space and pool heating systems are tied together and much of the heat added to the pool ultimately ends up in the air inside the building due to evaporation and the temperature difference between the pool and the air. Their greatest advantage is in humidity control.

* Ibid.

POTENTIAL REPLICATIONS

The feasibility of using solar energy to heat the various swimming pools depends to a large extent on whether solar applications are meant to strictly reduce fuel consumption or whether they are meant to be economically viable over a period of time. Capital costs are high and, if the swimming season is short, it is difficult to recover costs within a few years. Every pool heated with expensive oil has the potential to benefit from solar energy.

Taking an average summer day of 20^{o} C with sunshine on the collectors for six hours and the water gaining 6^{o} C on a single pass, the energy produced is 1.7×10^{6} kJ's. A litre of fuel has $.04 \times 10^{6}$ kJ, but with an oil boiler averaging 70% efficiency, only $.03 \times 10^{6}$ kJ are transferred to the water. A solar gain of 1.7×10^{6} kJ's means a savings of 57 litres of oil. At a cost of $.45 per litre, a savings of $26.00 could be realized, which would be approximately $750.00 per month. J.M. Bean & Co. Ltd. in its report, 1983 Evaluation Report on Seven Community Swimming Pools, states that the maximum saving that could be attributed to the solar system would not exceed $1,000.00 per month. Operating costs average $1,200.00 to $1,500.00 per month.

If the solar system provides half to two-thirds the average monthly operating costs, it makes a reasonably significant contribution. But

with solar systems costing approximately $20,000.00, the payback period is a minimum of seven to ten years.

The life expectancy of the solar system has yet to be determined, but hopefully it will outlast the payback period.

ENVIRONMENTAL IMPACT ASSESSMENT

The solar collectors are in no way detrimental to the environment as there is no combustion involved, no waste products, and no on-going transportation or transmission needs.

It is clean, safe, reduces our reliance on expensive imported fossil fuels and helps foster self-reliance.

OTHER CONSIDERATIONS

Points to be considered in installing a solar heating system for pools include the location of the building in relation to shading from other structures and trees, particularly in spring and fall when heating requirements are at their peak. Other important considerations include orientation and slope of the roof, and prevailing weather conditions, such as cooling winds.

Considerations such as whether additional costs for glazing of the collectors will be necessary, a pool blanket, and heating of shower water could be taken into account also.

If the system were to be installed on another pool, a more exact idea of how much energy is gained and how effective the system is during a variety of weather conditions would possible if the following records were kept on a daily basis:

- pool temperature before installation over the season,
- pool temperature after installation over the season,
- weather conditions such as daily minimum and maximum temperature readings, cloud cover, wind speed and direction and
- attendance for the season both before and after installation, noting school use and special occasions.

Other pertinent records taken both before and after installation would be fuel consumption, and the opening and closing dates of the season. A BTU meter would facilitate greatly in assessing the amount of energy collected.

CONCLUSIONS

The use of solar collectors in conjunction with a pool blanket was deemed a success by the Mayo LID manager who recommends that if the capital investment can be handled to install them. Pool temperatures were raised sufficiently to extend the swimming season by five weeks and to triple attendance without any significant population increase. However, the impact of solar heating of this pool is probably far more noticeable than it would be for the other pools in the territory which are heated by conventional fuels. When you have no other heating, the heat gained from solar energy is far more obvious. The other pools would likely gain a similar amount of energy from a solar system but it would be hidden in lower fuel consumption. Solar energy can supplement conventional fuels, but it is very expensive.

It is a clean and safe system which requires no additional maintenance and no major start-up or shut-down preparations in the spring and fall. The only thing that remains to be seen is the life expectancy of the system.

Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

Yukon
Department of Economic Development and Tourism

Solar Pool

Final Project Summary

Canada/Yukon Conservation and Renewable Energy Demonstration Program

Project No.
3766-4-9

Date:
January, 1985

Sectors:
Commercial

Project Locations:
Mayo, Yukon

Technology:
Solar

Jurisdiction:
Yukon

Project Manager:
Calvin Klippert

Status:
Completed

Purpose:

To demonstrate the feasibility of using solar energy to heat a previously unheated outdoor swimming pool.

Description:

A 25 m outdoor swimming pool was heated by solar collctors mounted on a support structure. To retain the heat a pool blanket covered the pool when it was not in use.

Contributors:

Canada/Yukon	$16,070.74
Applicant	6,115.49
Total	$22,186.23

Demonstrated Benefits:

Pool water was on the average 6°C to 10°C warmer after installation of the solar system and the pool blanket. The swimming season was extended five weeks and attendance tripled.

Further Information

Mayo L.I.D., Mayo, Yukon
David Arseneault, Information Officer, Energy and Mines Branch, Economic Development and Tourism, Government of Yukon, Box 2703, Whitehorse, Yukon Y1A 2C6 phone (403) 667-5384.

Economic Analysis:

Collectors	$10,368.00
Other Hardware	5,736.70
Labour	5,343.50
Freight	452.03
Lodgings	185.00
Tool Rental	101.00
Total	$22,186.23

This includes approximately $4,000 for the cost of the support structure for the collectors.

Technical Details:

130 m^2 of highly durable black plastic solar collectors were installed at an angle of 30^0 from the horizontal on a south facing support structure. A differential thermostat controlled the flow of pool water through the collectors. The existing pool pump was used to circulate the water. When the pool was not in use a pool blanket covered it to prevent heat loss through evaporation.